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Epibionts on *Flexopecten felipponei* (Dall, 1922), an uncommon scallop from Argentina

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Abstract: *Flexopecten felipponei* (Dall, 1922) is a non-commercial, seldom reported pectinid from the SW Atlantic Ocean. In this contribution we review its taxonomy, describe epifaunal species and their levels of encrustation, and discuss the composition of the macrobenthic assemblage where this scallop lives. Eighteen epibiont taxa were observed to live on the valves of these scallops. The most frequent and abundant epibionts on *F. felipponei* were serpulids, barnacles, and oysters. Although both valves were encrusted, the left valves had higher percentages of coverage. The benthic community contained 69 invertebrate taxa that generally characterize other mid-shelf bottoms between 37°S and 39°S. Eight pea crabs of the species *Tumidotheres maculatus* (Say, 1818) were found inside eight individuals of *F. felipponei*. Two other scallops had burrows of *Polydora websteri* Hartman, 1943. These were the first observations of these infestations on *F. felipponei*.

Key words: Epibiosis, Pectinidae, SW Atlantic Ocean

Scallops are distributed worldwide and support important commercial fisheries and mariculture efforts. They are one of the best known groups of bivalves. Numerous studies on the biology, anatomy, physiology, genetics, population dynamics, fishery, and aquaculture of commercial pectinids have been carried out (see Shumway and Parsons 1991). In Argentina, the commercial pectinids include *Aequipecten tehuelchus* (d'Orbigny, 1846) and *Zygochlamys patagonica* (King and Broderip, 1832) (Ciocco *et al.* 2006), target species of a local fishery in the gulfs of northern Patagonia (Lasta *et al.* 1998, Ciocco *et al.* 1998) and of a fishery that started in 1996 (Lasta and Bremec 1998), respectively.

During the course of cruises conducted in 2002 to locate new commercial beds of *Aequipecten tehuelchus* in the coastal shelf waters of Buenos Aires, we observed the presence of the non-commercial pectinid *Flexopecten felipponei* (Dall, 1922) as part of the benthic community. The species has rarely been recorded from the SW Atlantic Ocean (Waller 1991). It is distributed from 36°S to San Matías and Nuevo Gulfs (43°S), and has been collected in rocky and sandy bottoms from the lower tidal fringe (Castellanos 1970, 1971) and between 40 to 50 m depth (Ríos 1994, Nuñez Cortés and Narosky 1997). The only biological study on *F. felipponei* indicates that it is a simultaneous hermaphrodite (Penchaszadeh and Giménez 2001).

The availability of a suitable substratum is one of the critical factors for the colonization of sessile species. Molluscs, decapod carapaces, and the spines of sea urchins are frequently used as hard substrata available for attachment of sessile organisms in soft bottoms, together with many other organisms such as ascidians, corals, gorgonians, and sea pens that are also used as surfaces for settlement by invertebrate larvae (Abelló *et al.* 1990, Davis and White 1994, Gutt and Schickan 1998). Epibiosis is the association between epibionts (organisms growing attached to a living surface) and basibionts (organisms that provide substrate to the epibionts). This association creates a complex network of benefits and disadvantages for both organisms (Wahl 1989). Bivalves are often associated with encrusting epibionts (see Feifarek 1987, Vance 1978, Keough 1984). Epizoic organisms can be very diverse, especially on scallops (*i.e.*, Waloszek 1991, Rosso and Sanfilippo 1994, Fuller *et al.* 1998, Bremec and Lasta 2002). Studies examining the epibiosis between scallops and other organisms include foraminiferans (Alexander and Delaca 1987), sponges (Evans 1969, Bloom 1975, Forester 1979, Chernoff 1987, Burns and Bingham 2002, Donovan *et al.* 2002), hydroids (Getchell 1991), polychaetes (Blake and Evans 1973, Bergman *et al.* 1982, Mori *et al.* 1985, Ciocco 1990, Sanfilippo 1994), crustaceans (Donovan *et al.* 2003), bryozoans (Ward and Thorpe 1991), and ascidians (see Uribe *et al.* 2001 and references therein).

In this contribution we give new information about *Flexopecten felipponei* from coastal shelf waters of Buenos Aires, Argentina. We review its taxonomy, describe epifaunal species and their levels of encrustation, and discuss the composition of the macrobenthic assemblage where this scallop lives.

MATERIALS AND METHODS

Sampling was conducted with commercial otter trawls (51 hauls) by the scallopers *Atlantic Surf I*, *Erin Bruce*, and *Mr. Big*, between 40-50 m depth and between 39°00'-

39°37′S and 60°21′- 58°47′W in February, July, August, and September 2002, and with a dredge by the research vessel *Capitán Cánepa* (INIDEP) at 38°26′S and 57°40′W in January 2004 (Fig. 1). Samples of the macrobenthic community were frozen on board. The species of macroinvertebrates comprising this community were identified to the lowest possible level in the laboratory using the available literature (Bernasconi 1964, 1973, Castellanos 1970, Orensanz 1975, Fauchald 1977, Bernasconi and D'Agostino 1977, Boschi *et al.* 1992, Lana and Bremec 1994, Roux and Bremec 1996, Pérez 1999, and Forcelli 2000). The identification of ascidians was made by Dr. Marcos Tatián.

From a total of 95 specimens of *Flexopecten felipponei* identified in 26 hauls, we preserved 30 available specimens in 5% buffered formalin solution in seawater. Presence-absence and quantitative data of epibionts were recorded for right and left valves. A Wilcoxon matched paired test (Steel and Torrie 1985) was used to establish the significance in differences between total abundances of epibionts on each valve. To quantify the level of encrustation, each valve was arbitrarily divided into seven regions (Fig. 2), roughly following the procedures of Ward and Thorpe (1991) and Sanfilippo (1994). The percentage of coverage of each species of epibiont was estimated by eye as either <10%, 10-30%, or >30% of the surface for each region of each valve. Maximum shell width was measured to the nearest mm with calipers (Fig. 2).

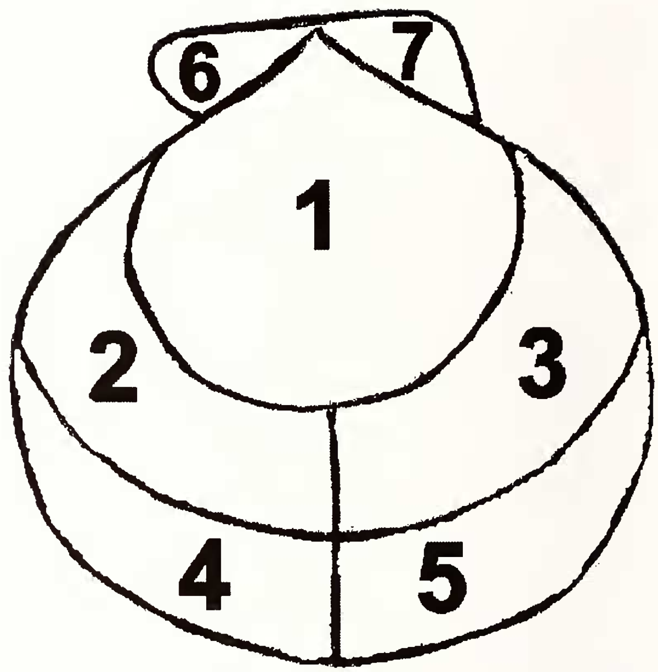

Figure 2. Diagram showing division of each valve into 7 arbitrary regions and the measurement of maximum shell width.

RESULTS

Taxonomy

Our study material agreed well with the original description of *Flexopecten felipponei* (Dall, 1922). The genus belongs to the Decatopecten group (Waller 1991) and is characterized by plain shells with 5-8 ribs that are sometimes inconspicuous. *Flexopecten felipponei* is an uncommon species from the Argentine Sea. It has been synonymized as:

Flexopecten felipponei (Dall, 1922)

Pecten felipponei: Dall 1922; Carcelles 1944
Chlamys felipponei: Castellanos 1970,1971; Waloszek 1984; Rombouts 1991; Ríos 1994; Nuñez Cortés and Narosky 1997; Forcelli 2000
Aequipecten felipponei: Nuñez Cortés and Narosky 1997; Penchaszadeh and Giménez 2001
Flexopecten felipponei: Waller 1991; Peña 2001

We follow the nomenclature proposed by Waller (1991), who assigns the species to the genus *Flexopecten* based on the external morphology of the shell.

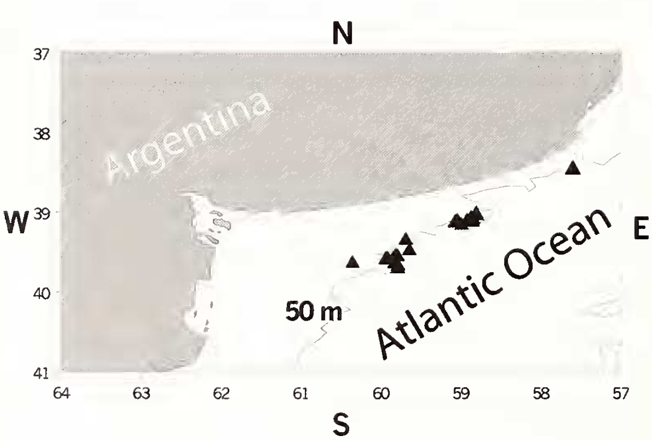

Figure 1. Map of the sampling area. Triangles mark sampling sites.

Epibiosis

Epibionts were present on both valves of all studied individuals of *Flexopecten felipponei.* Tube-building polychaetes, barnacles, and oysters were the most frequent epizoic organisms on both valves (Fig. 3). Significant differences were found in total number of epibionts recorded between both valves ($Z = 3.3629$, $p < 0.001$); the highest number of organisms was always found on the upper (left) valve.

Serpulid tubes were present on 90% of the sampled scallops and were found on both valves (Fig. 4). These tubes were found in all 7 regions on both valves, with variable

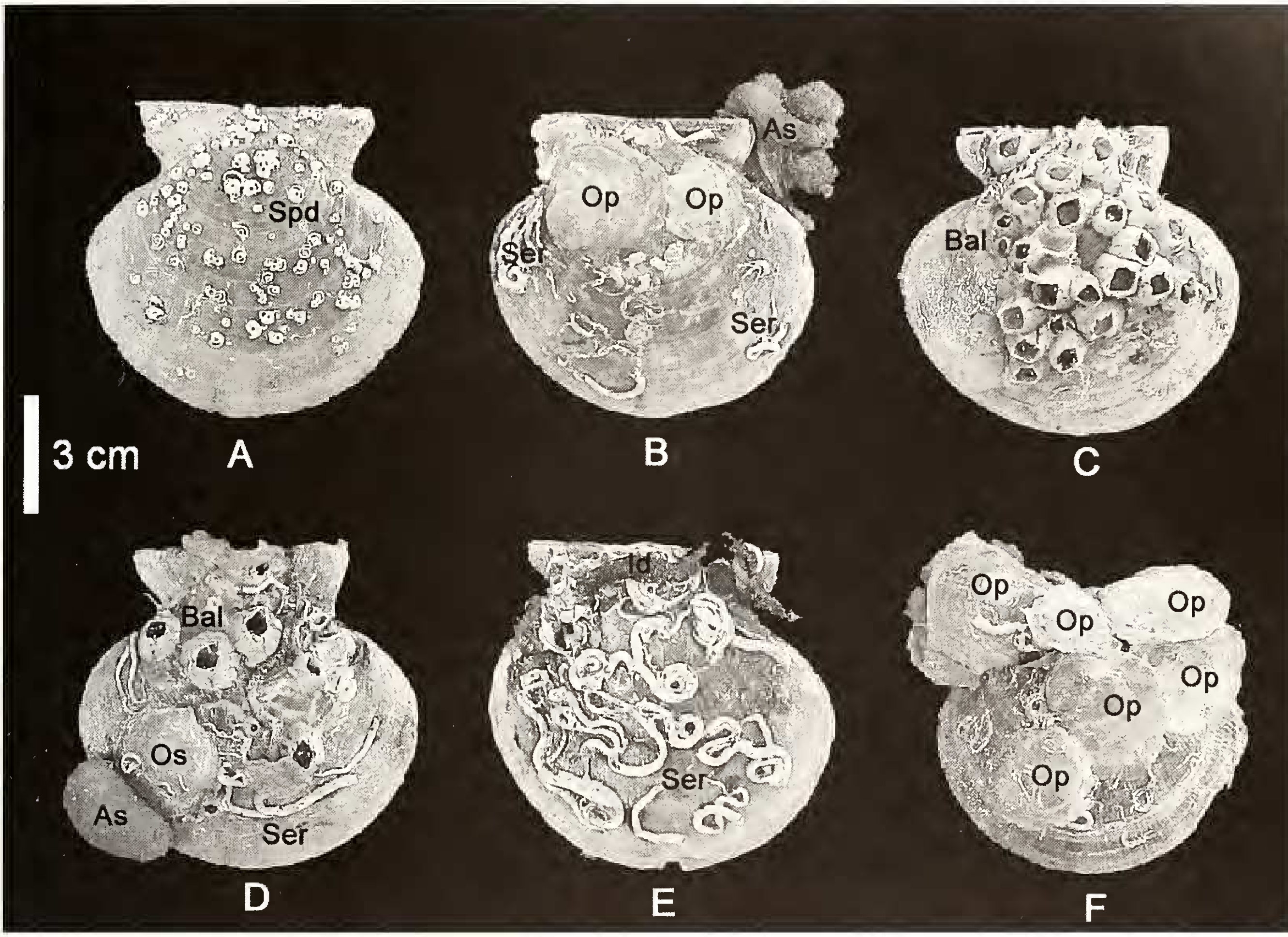

Figure 3. Epizoic organisms on *Flexopecten felipponei* from the coastal shelf waters of Buenos Aires. A, Spirorbid polychaetes. B, Several individuals of *Ostrea puelchana* d'Orbigny, 1841, ascidians, and some serpulid tubes. C, *Balanus* cf. *amphitrite*. D, *Balanus* cf. *amphitrite*, ascidians, serpulid tubes, and individuals of *Ostrea puelchana*. E, *Idanthyrsus armatus* Kinberg, 1867 (Sabellariidae) and serpulid tubes. F, *Ostrea puelchana*, some with serpulid tubes on them. Abbreviations: As, ascidian; Bal, *Balanus* cf. *amphitrite*; Ia, *Idanthyrsus armatus*; Op, *Ostrea puelchana*; Ser, Serpulid polychaetes; Spd, Spirorbid polychaetes.

percentages of covered surface in each region (Fig. 5A-B). In some cases the complete valve was covered, while in others only a few tubes were found (Fig. 3). The number of tubes found on a single valve varied between 1 and 65. Serpulids were also epibionts of other epibionts of *Flexopecten felipponei*. For example, they also occurred on epizoic individuals of *Ostrea puelchana* d'Orbigny, 1842 (Fig. 3D-F). Only 3 small individuals (<26 mm maximum height) of *F. felipponei* had valves that lacked serpulid tubes. Tubes of the polychaete *Phyllochaetopterus* sp. were found on both valves (left: 60%; right: 46.7%) (Fig. 4). These tubes were small and consequently covered small surfaces (<10%). They were found on both valves, more abundantly on the left (2-16 tubes) than on the right (1-5 tubes). Tubes of *Idanthyrsus armatus* Kinberg, 1867 were found only on left valves in 33.3% of the sampled scallops (Fig. 4). These tubes were found on the left valves in any of the 7 regions, but there was generally only one tube per valve. In some cases, the open region of the tube extended over the valve (Fig. 3E). Spirorbid tubes were very abundant on 3 (10%) scallops belonging to a particular sample (Fig. 4). In any case, they were not frequent epibionts on *F. felipponei*; only 3 scallops had between 47 and 224 tubes per valve, which were homogeneously distributed on both valves (Fig. 3A). Members of the Eunicidae (*Eunice magellanica* Mc Intosh, 1885 and *Eunice argentinensis* [Treadwell, 1929]) were recorded on only a few scallops (Fig. 4). A few burrows of the parasitic polychaete *Polydora websteri* Hartman, 1943 were found on 2 left (upper) valves (6.67%).

Barnacles (*Balanus* cf. *amphitrite*) were found on 26

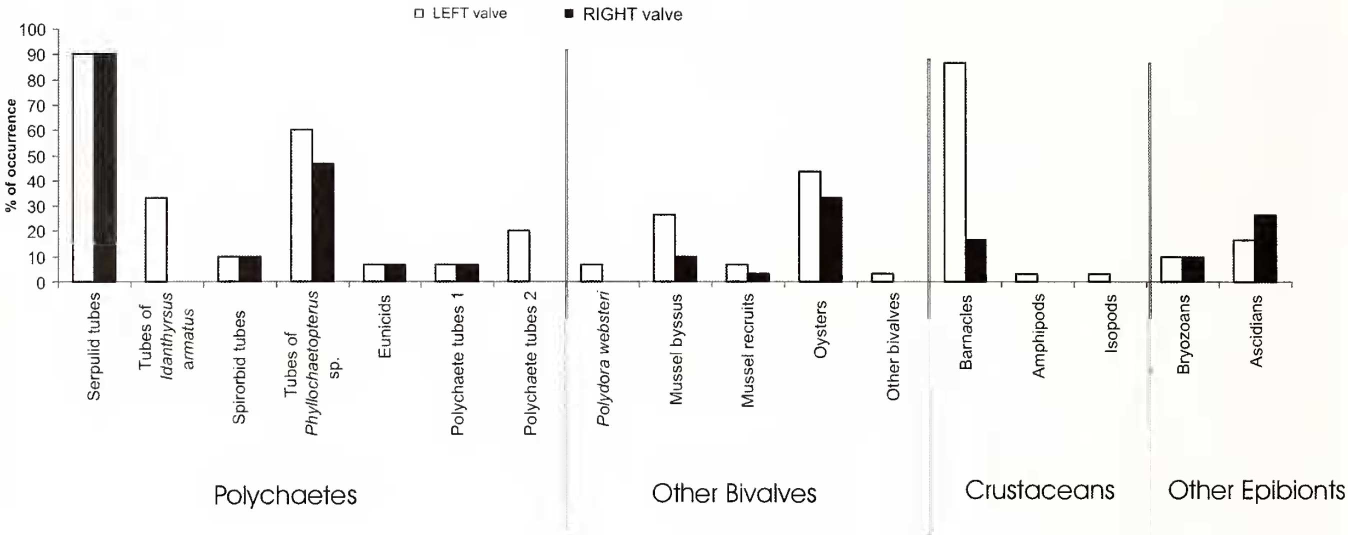

Figure 4. Frequency of occurrence of epibionts on *Flexopecten felipponei* (based on presence-absence data, N = 30).

(86.7%) left valves, but only on 5 (16.7%) of the right ones (Fig. 4). They were found most frequently on the left (upper) valves, with high values of coverage especially at regions 1, 2, 3, and 6 (Fig. 5C-D). The left valves had between 1 and 36 individual barnacles, and the right valves between 1 and 4 individuals. Region 1 of the valve was conspicuously preferred as a settlement surface; in some cases it was completely covered by barnacles (Fig. 3C).

Oysters (*Ostrea puelchana*) were found on 43.3% and 33.3% of the left and right valves, respectively (Fig. 4). They were found on both valves and in all regions (Fig. 5E-F). In many cases, the oysters completely covered the auricular areas or extended over the edges of the scallops (Fig. 3F). Numbers of epizoic oysters varied between 1 and 9. Serpulids and individuals of *Phyllochaetopterus* sp. also encrusted epizoic oysters (Fig. 3B, D, F). Recruits of the mussel *Mytilus edulis* d'Orbigny, 1846 and other unidentified small bivalves were recorded as epibionts on a few scallops (Fig. 4).

Solitary ascidians were found on 16.7% and 26.7% of the left and right scallop valves, respectively (Fig. 4). These organisms were observed in low numbers (1-2), on both valves, and in all regions (*i.e.*, Fig. 3B-D). Epizoic organisms such as bryozoan colonies, small isopods, and amphipods were also observed on a few scallops (Fig. 4). The crustaceans were free-living between the crevices in the association of epibionts.

There were no shells without epibionts; even small individuals had epizoic organisms on their valves.

Macrobenthic assemblage

Individuals of *Flexopecten felipponei* (between 16 and 90 mm maximum shell width) were primarily found associated with the tehuelche scallop *Aequipecten tehuelchus*, as part of the by-catch of the fishery. Other organisms of commercial importance found in the benthic community were the common mussel *Mytilus edulis*, the oyster *Ostrea puelchana*, and the mussel *Atrina seminuda* (d'Orbigny, 1846). A total of 69 invertebrate taxa were recorded from the study area (Table 1).

Infestation

Seven females (between 6.6 and 9.6 mm carapace length) and one male (3.8 mm carapace length) of the pea crab *Tumidotheres maculatus* (Say, 1818) were found inside eight different specimens of *Flexopecten felipponei*. Two left scallop valves were burrowed into by the parasitic polychaete *Polydora websteri*.

DISCUSSION

We found 18 epizoic taxa on the valves of *Flexopecten felipponei* from the sublittoral of Buenos Aires. The most frequent and abundant epibionts on *Flexopecten felipponei* were serpulids, barnacles, and oysters. Additional organisms such as the gastropods *Calliostoma* sp., *Crepidula* spp. and *Calyptraea* sp. occured as part of the fauna closely related with the epibiont association. Previously, only the presence of bryozoans and polychaetes on five specimens of this scallop was mentioned by Castellanos (1971).

The number of associated species greatly varies in different species of scallops recorded from different habitats. Eleven species were found on cultured *Euvola ziczac* (Linnaeus, 1758) and *Nodipecten nodosus* (Linnaeus, 1758) in Cariaco Gulf, Venezuela, but in Santa Catarina, Brazil, 16

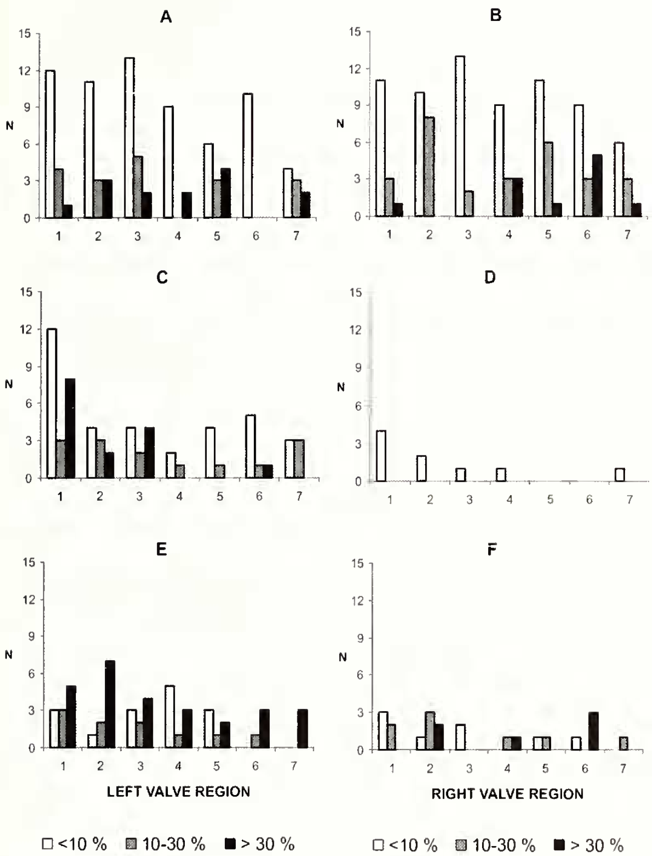

Figure 5. Portion of the surface (%) of each region of each valve of *Flexopecten felipponei* covered by: A-B, serpulids; C-D, barnacles; E-F, oysters.

species were found on *N. nodosus*. In Magdalena Bay and Bahía de la Paz, Mexico, 36 species were found inside or outside the valves of *Argopecten ventricosus* (Sowerby II, 1842) and *Nodipecten subnodosus* (Sowerby, 1835). In Tongoy, Guanaqueros, and Inglesa Bays, Chile, a total of 63 species were recorded associated with the valves of *Argopecten purpuratus* (Lamarck, 1819) (Uribe *et al.* 2001). Forty nine epizoic taxa were associated with the non-cultured species *Placopecten magellanicus* (Gmelin, 1791) in the Bay of Fundy, Canada (Fuller *et al.* 1998) and 19 sessile epizoic species were recorded on *Zygochlamys patagonica* in commercial beds of Argentina (Bremec and Lasta 2002, Bremec *et al.* 2003).

Although both valves were encrusted, the left (upper) valves had higher percentages of coverage. Except for ascidians, the epibiont species were more abundant on the left valve and occured on all regions. *Flexopecten felipponei* is a non-sedentary species that should have limited swimming capacity (Stanley 1970), which would permit it to escape from predators, as observed in other scallops (see Wilkens 1991). Epibionts can settle on both valves, depending on the living position adopted by the scallop, which seems to be more frequently with the right valve in contact with the substrate.

Surprisingly, no sponges were found on our specimens of *Flexopecten felipponei*. The symbiotic relationship between scallops and sponges has been studied worldwide (Bloom 1975, Forester 1979, Chernoff 1987, Burns and Bingham 2002, Donovan *et al.* 2002). Cover by sponges is believed to protect pectinids by camouflaging the shell and to reduce predation by asteroids by altering the surface texture of shells. Although we found sponges in the study area, they were encrusting other invertebrates, mainly crustaceans and eunicid tubes.

The majority of the epibionts on *Flexopecten felipponei* were sessile suspension-feeders. They created additional surfaces and crevices where other small free-living individuals, such as isopods and amphipods, could live. We found only a small number of free-living organisms inhabiting the epizoic association. However, we consider that the number of vagile species associated with this scallop is higher and underestimated due to the limitations of our sampling procedure.

Many of the macroinvertebrates that were part of the benthic assemblage associated with *Flexopecten felipponei* were also recorded from other middle shelf bottoms between 37°S and 39°S where the mussel *Mytilus edulis* was dominant. The coastal area of Buenos Aires is highly heterogeneous, with patches of different types of substrates, and the most diversified benthic assemblages are usually dominated by bivalves (Bremec and Roux 1997, Schejter and Bremec 2003). The settlement substrate and microhabitats provided by bivalves and associated epibionts greatly influence community structure by increasing the species richness of the benthic assemblages. In our study area, where the soft bottoms are subjected to hydrodynamic conditions that remove sediments, the scallops provided substrate for the settlement of encrusting filter feeders and permitted the colonization of coastal environments.

This is the first record of *Flexopecten felipponei* as a host of the spionid polychaete *Polydora websteri* and the pea crab *Tumidotheres maculatus*. Species of the genus *Polydora* are reported to be a pest of bivalves (Getchell 1991). They have been found in many commercial species such as *Placopecten magellanicus* (Bergman *et al.* 1982), *Argopecten purpuratus* (Basilio *et al.* 1995), *Patinopecten yessoensis* (Jay, 1857) (Mori *et al.* 1985), *Pecten maximus* (Linnaeus, 1758) (Mortensen *et al.* 2000), and *Aequipecten tehuelchus* (Ciocco 1990). Pea crabs cause slight irritation to severe structural alterations and pathology in their scallop hosts (Kruckzynski 1972, Getchell 1991, Bologna and Heck 2000, Narvarte and Saiz 2004). *Tumidotheres maculatus* was also reported inside sev-

Table 1. Invertebrates recorded from the study area.

PORIFERA	
	Porifera unidentified
CNIDARIA	
	Tripalea clavaria (Studer, 1878)
	Actinaria unidentified
	Hydrozoa
ANNELIDA	
	Aphroditidae
	Eunice magellanica McIntosh, 1885
	Chaetopterus variopedatus (Ranier, 1807)
	Phyllochaetopterus sp.
	Idanthyrsus armatus Kinberg, 1867
	Polydora websteri Hartman, 1943
	Spirorbidae
	Serpulidae
	Maldanidae
	Polychaeta unidentified
MOLLUSCA	
	Aequipecten tehuelchus (d'Orbigny, 1846)
	Flexopecten felipponei (Dall, 1922)
	Ostrea puelchana d'Orbigny, 1841
	Pododesmus rudis (Broderip, 1834)
	Mytilus edulis d'Orbigny, 1846
	Atrina seminuda (d'Orbigny, 1846)
	Panopea abbreviata (Valenciennes, 1839)
	Pitar rostrata (Koch, 1844)
	Bivalve unidentified
	Calyptraea sp.
	Crepidula spp.
	Calliostoma sp.
	Zidona dufresnei (Donovan, 1823)
	Fissurellidea megatrema d'Orbigny, 1841
	Nudibranchia
	Octopus tehuelchus d'Orbigny, 1834
ARTHROPODA	
	Peltarion spinosulum (White, 1843)
	Platyxanthus patagonicus A. Milne Edwards, 1879
	Coenophthalmus tridentatus A. Milne Edwards, 1879
	Rochinia gracilipes A. Milne Edwards, 1875
	Collodes rostratus A. Milne Edward, 1878
	Pilumnoides hassleri A. Milne Edward, 1880
	Leurocyclus tuberculosus (H. Milne Edwards and Lucas, 1843)
	Libinia spinosa H. Milne Edwards, 1834
	Pelia rotunda A. Milne Edwards, 1875
	Leucipa pentagona H. Milne Edwards, 1833
	Propagurus gaudichaudi (H. Milne Edwards, 1836)
	Pagurus sp.
	Pinnotheridae
	Tumidotheres maculatus (Say, 1818)
	Pinnixa brevipollex Rathbun, 1896
	Balanus cf. *amphitrite*
	Lepadomorpha
	Amphipoda unidentified
	Isopoda unidentified
ECHINODERMATA	
	Arbacia dufresnei (Blainville, 1825)
	Pseudechinus magellanicus (Philippi, 1857)
	Astropecten brasiliensis Müller and Troschel, 1842
	Luidia sp.
	Pterasteridae
	Asteroidea 1
	Asteroidea 2
	Asteroidea 3
	Asteroidea 4
	Ophioplocus januarii (Lütken, 1856)
	Ophiactis asperula (Philippi, 1858)
	Ophiacanta vivipara Ljungman, 1870
BRACHIOPODA	
	Magellania venosa (Solander, 1816)
BRYOZOA	
	Colonial Bryozoa unidentified
CHORDATA	
	Paramolgula gregaria (Lesson, 1830)
	Cnemidocarpa robinsoni Hartmeyer, 1916
	Pyura legumen (Lesson, 1830)
	Ascidiella aspersa (Müller, 1776)
	Sycozoa sigillinoides Lesson, 1830
	Colonial Ascidacea unidentified

eral mollusks, in the tunicate *Molgula* sp., inside tubes of the polychaete *Chaetopterus variopedatus* (Renier, 1804), and on the asteroid *Asterias vulgaris* Verril, 1866 (Fenucci 1975).

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